DOCUMENT RESUME

ED 255 174 IR 011 543

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TITLE The Spreadsheet in an Educational Setting. Microcomputing Working Paper Series F 84-4.
INSTITUTION Drexel Univ., Philadelphia, PA. Microcomputing Program.
REPORT NO MWPS-F-84-4
PUB DATE Oct 84
NOTE 25p.; For related documents, see IR 011 540-544.
AVAILABLE FROM Working Paper Series, Microcomputing Program, Office of the Vice President for Academic Affairs, Drexel University, 32nd and Chestnut Streets, Philadelphia, PA 19104.
PUB TYPE Guides - Non-Classroom Use (055) -- Reports - Descriptive (141)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS College Faculty; *Computation; *Computer Software; *Databases; Decision Making; Higher Education; Material Development; *Mathematical Applications; *Microcomputers; Program Descriptions
IDENTIFIERS Apple Macintosh; Drexel University PA; *Spreadsheets

ABSTRACT

This overview of a specific spreadsheet, Microsoft's Multiplan for the Apple Macintosh microcomputer, emphasizes specific features that are important to the academic community, including the mathematical functions of algebra, trigonometry, and statistical analysis. Additional features are summarized, including data formats for both numerical and textual data, and instructions on how to use a simple spreadsheet are provided. The following examples of spreadsheets are described and illustrated with figures: (1) Grade Tally, for computing grades; (2) Production Decisions, a decision analysis tool which compares the costs of four different methods of making the same quantity of a product to determine the least costly method; (3) Nutritional Analysis, a database of foods and their nutritional value; (4) Chemical Equilibrium Calculations, three spreadsheets that use Multiplan to perform calculations on the properties of solutions of weak acids and bases, including buffer solutions; (5) Least Squares Analysis, or linear regression, a statistical tool to judge how observed pairs of data best fit a straight line; and (6) Production Possibility Curve, which students create as a homework assignment. (LMM)

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THE SPREADSHEET IN AN EDUCATIONAL SETTING

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MWPS F 84-4
October, 1984

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THE SPREADSHEET IN AN EDUCATIONAL SETTING

Spreadsheets: The Evolution of a Software Tool

Spreadsheets began as tools in the hands of accountants and businessmen who, indicative of the title, spread a sheet in front of themselves and calculated the finances of the company on paper. They entered a figure here, a figure there, erased this calculation, and penciled in the result of that calculation. It was easy to imagine a very large desk or table, complete with a hand-held calculator and scotch tape handy for the next section that must be added. If they wanted to consider the future of the company ("What if we increase productivity during the third quarter this year?"), they had to recalcule, erase, and enter the modified figures. It was up to the accountant or businessman to recall every calculation and reference on the sheet. The validity of the spreadsheet depended upon it.

Spreadsheets are no longer used solely as a businessman's tool. Now they are also used in a variety of situations, including classroom instruction, research, and recordkeeping on the college campus. Applications from simple expense reports or grade sheets to complex financial or scientific calculations can all be performed on a spreadsheet.

The most obvious change in the spreadsheet is the transition from a manual tool to an electronic one. The most recent spreadsheets do repetitive or tedious calculations and keep track of all interconnected calculations. As a matter of fact, a spreadsheet can be used for any application that requires single or repetitive calculation. Because of the ease in changing the figures that are input into a calculation, the spreadsheet more than ever can be used in a "what if" situation. "What if the U.S. deficit reaches ten trillion dollars?" "What if I change the grade curve in this class - how many A's will result?" In the case of one specific spreadsheet, Microsoft's Multiplan™ for the Apple Macintosh™, capabilities go well beyond the traditional functions of a hand-held calculator. Mathematical, logical, and text manipulation functions are possible on

Multiplan. Any sort of tabular data is easily handled. The spreadsheet has truly become a multi-purpose tool.

This paper will give an overview of the functions of Multiplan, specific features that have proven important to the academic community, and basic information on the creation of a simple spreadsheet. It also presents examples of spreadsheets developed by Drexel University faculty and staff. A companion paper to this, "The Spreadsheet as a Programming Tool" by Stanley Cohen, discusses the spreadsheet's capabilities as a programming language.

Overview of Multiplan Functions

Mathematical functions on an electronic spreadsheet go beyond the four functions of a calculator to include those of algebra, trigonometry, and statistical analysis. Multiplan's capabilities extend to functions from the absolute value or the square root of a number to logarithms, both natural and base 10. The trigonometric functions of the sine, cosine, tangent, and arctangent are available. Simple statistical functions built into Multiplan include the minimum, maximum, average, and standard deviation. The complete list of built-in mathematical tools is included in Figure 1. Of course, the list is expandable as functions are combined to create a specific formula.

The choice of mathematical function is entirely dependent upon the purpose of the spreadsheet. Of the example spreadsheets presented here, one (Figure 6. Nutritional Analysis) relies solely on addition, multiplication, and division, yet it is complex in other ways. At the other extreme, the least squares analysis (Figure 9.) uses a complex series of calculations to test the linear relationship of pairs of data points.

Logical functions in Multiplan include the standard Boolean operators ("and", "or", "not"). "if" conditions, and true and false tests. The "if" statement, in particular, is probably the most useful logical tool on a spreadsheet in that it can be used in a variety of situations to generate the desired output. In the example spreadsheets, over half use the "if"

Command	Function
ABS	Absolute value of a number
ATAN	Arctangent
AVERAGE	Average of the values in the list
COS	Cosine
COUNT	Count of the number of items in the list
EXP	Exponentiation
INT	Integer portion of a number
LN	Natural logarithm
LOG10	Base 10 logarithm
MAX	Maximum value in list
MIN	Minimum value in list
MOD	Remainder after division
NPV	Net present value of list at rate
ROUND	Number rounded to a number of digits
SIGN	Sign of a number (1 positive, -1 negative)
SIN	Sine
SQRT	Square root
STDEV	Standard deviation
SUM	Sum of numbers in list
TAN	Tangent

Figure 1: Mathematical Tools Built into Multiplan

statement to some purpose. The sheet on decision analysis (Figure 4.) uses it to choose a production method for a hypothetical product. The least squares analysis (Figure 9.) uses it to graph a series of negative and positive numbers. The weak acid equilibrium spreadsheet (Figure 7.) generates error messages if the results of the calculations based on input are not valid.

Multiplan allows certain text and table manipulation functions: sorting a table on a specified set of values in ascending or descending order, retrieving a value in a specified cell of a table, and concatenating the contents of cells to other cells or to textual or numeric strings. Multiplan also allows the user to look up a number in a table and return text or numerical items corresponding to the number that is looked up. The grade sheet example in Figure 3. uses two of these manipulations: sorting and the look-up table.

Other Features Important to the Academic Community

In addition to the manipulative functions, Multiplan contains other features that are useful to the academic community. The package has a full complement of data formats for both numerical and textual data. For instance, the user can represent numbers as dollars, decimals, scientific notation, or bar graphs. It is possible to left-justify, right-justify, or center data or text. Related to this is the ability to include comments and explanations directly on the spreadsheets. Unlike other spreadsheets, Multiplan automatically "spills over" into adjacent unused cells when text is entered. This makes it easy to type in a multi-cell comment, without being concerned about how many characters will fit into a cell.

The user is able to name cells and sections of the spreadsheet and use the names in formulas. Thus a formula such as "R[-1]C*R[-2]C%" is typed in as "PRINCIPLE*INTEREST%". The user names the cells that represent the principle (R[-1]C) and interest (R[-2]C) and Multiplan then uses those cells in its calculation. Naming cells is also important when a user wants to move quickly to a different section of a large sheet. By naming a cell

"JULY", for instance, a user can tell Multiplan to move to the cell named "JULY" without having to scroll around a large spreadsheet to find "JULY" or try to remember a cell reference like R26C78 (row 26, column 78).

With Multiplan a user can "write protect" single cells or an entire sheet so that new formulas and data can be entered only in those cells which are unprotected. This feature is obviously useful for professors who wish to develop spreadsheets for their students. By protecting sections of the spreadsheet and leaving others free for input, a professor can create a spreadsheet for student use without fear of having the underlying formulas accidentally changed by the students. A password is required to release the protection so that formulas or data in the protected cells can be changed. Multiplan indicates to the user that a cell or a sheet is protected or unprotected by the manner in which it delineates cells. On unprotected sheets, all cells look like cells; that is, the whole sheet is covered by a grid. (See Figure 4. for an example of an unprotected sheet.) Protected sheets do not show this grid. Instead, locations of unprotected cells are indicated by dotted lines on which data is to be entered. (See Figure 7. for an example of a protected sheet.) By protecting all but the cells where data is to be entered, an instructor can insure that the formulas which act upon the data remain unchanged and that there is no mistake about where data is to be introduced.

The Apple Macintosh provides integration between Multiplan and its word processor, MacWrite. That is to say, a table can be created in Multiplan and incorporated into a MacWrite document, or an explanation can be given using MacWrite and incorporated into Multiplan. In this way, Multiplan tables can be included in student assignments and reports written using MacWrite.

How to "Spreadsheet"

First-time users of the spreadsheet may find that they do not come to the means of setting up a sheet and performing calculations naturally. As a matter of fact, the most difficult part of creating a spreadsheet is generating the idea for the sheet. The next difficult part is organizing the

idea into the form of a spreadsheet. "How exactly do I express what I want to do?" These two areas are difficult to address. They are dependent upon the person who is doing the "spreadsheeting", his familiarity with the spreadsheet functions, and his ability to transform his methods into spreadsheet formulas. The descriptive examples that are included in this paper give some idea of types of spreadsheets that have been developed on one college campus. The following, therefore, is simply a brief "how-to-do-it" which assumes the reader already knows what he wants to do.

The actual set-up of a sheet, once the idea and the basic form are known, is relatively easy on Multiplan. Macintosh has a very useful mechanical device called a "mouse" that moves a pointer around a spreadsheet. By pointing with the mouse and clicking the button on the mouse, the user selects a cell or a series of cells that he wants to manipulate. This makes it extremely easy to get around the spreadsheet and to enter cells for calculation. The ability to name cells, as discussed earlier, adds to the facility in creating an understandable spreadsheet.

The user enters two types of input: raw data and formulas. Raw data is any static number or text which may or may not be formatted. "Ten", "10", and "$10.00" are all examples of raw data. Formulas are operations on raw data or cells that contain raw data, such as "=5*2". The results of the formula appear in the cell. In the case of "=5*2", the cell display is "10". Formulas in Multiplan are signalled by the equals sign that begins them.

References to cells can either be absolute or relative references. The difference between these two concepts is important. An absolute reference refers to exactly the same cell each time it is used, such as "R27C68" (Row 27, Column 68). Named cells are absolute references. For instance, a cell named "INTEREST" is one cell on the sheet and is in the same spot every time 'INTEREST' is used. By contrast, a relative reference is used whenever a user wants a cell relative to the cell where he is entering data or a formula. Relative references in Multiplan read "R[-1]C[-2]". That is to say, the reference is one row up and two columns to the left of the cell that is currently selected. An example of the difference between absolute and

relative references is a personal check register. The beginning balance is an absolute reference: it is in the same cell on a spreadsheet and in only one cell. Continuing balances are computed with related referencing; the previous balance is always one row up from the current balance.

Consider the following spreadsheet:

	1	2
1	EXPENSES FOR JANUARY	
2		
3	Credit Cards	203.89
4	Phone	34.22
5	Electricity	23.76
6	Rent	425
7		
8	Total	686.87

Figure 2. Expense Sheet

This spreadsheet was created by two basic steps: the data was entered in separate cells (nature of expense and amount) and the amounts were totaled. To enter the data using Multiplan on the Macintosh, the user simply used the mouse to point to the cell where the data should go, clicked once on the mouse to select that cell, and typed in the data (Figure 2a.). To calculate the sum of the amounts, the user pointed to and selected the cell where the sum should appear, typed "=SUM(" (Figure 2b.). Then, holding the mouse button down, the user dragged the mouse down the entire column of data to be summed, and the resulting formula was automatically filled in (Figure 2c.). The final step was to close the parenthesis by typing ")" (Figure 2d.) and to enter the command by pressing the ENTER key on the keyboard, which results in the automatic display of the resulting calculation (Figure 2e.).

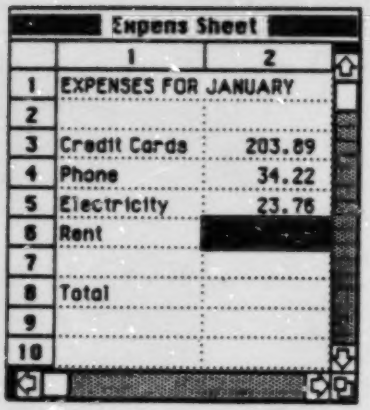

Figure 2a. Entering Data

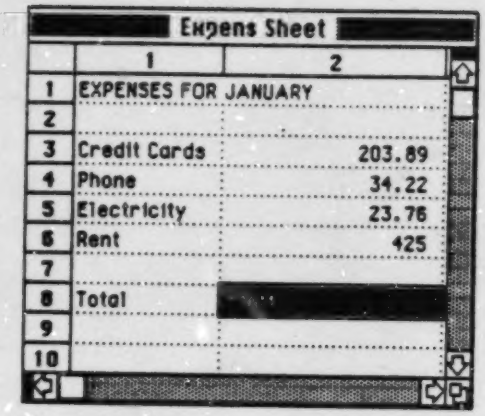

Figure 2b. Entering Sum Command

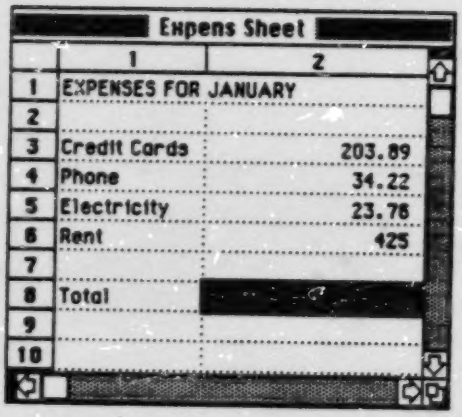

Figure 2c. Specifying What To Sum

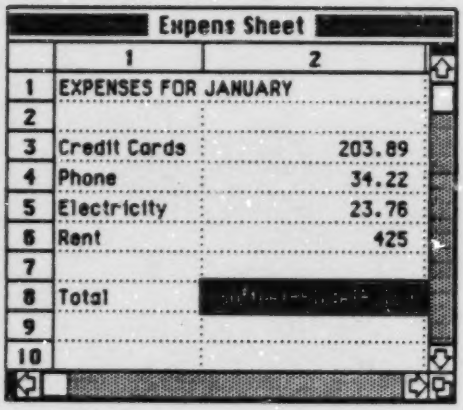

Figure 2d. Finishing Sum Instruction

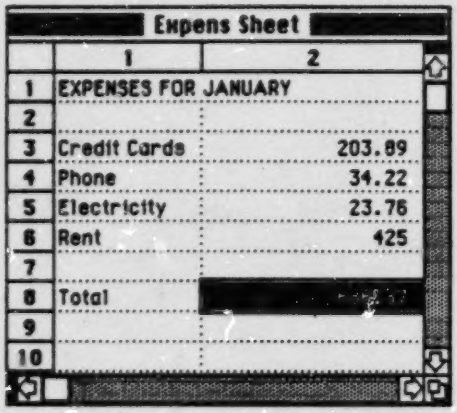

Figure 2e. Executing the Calculation

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Although a formula was required to arrive at the balance, the user was not required to fill it in.

Sample Spreadsheets in an Educational Setting

The following spreadsheets were created by the faculty and staff at Drexel University. The descriptions of the spreadsheets are meant to be read by the general reader. Although the subject matter of a particular sheet may be foreign to the reader, the descriptions stress underlying ideas and techniques, rather than the actual content of the sheets.

Grade Tally.[1] The grade tally sheet (Figure 3) is a straightforward sheet for computing grades. Student names are followed by their grades on tests. The average is computed using the AVERAGE function, which takes the average of a set of numbers. The letter grade is computed by a function called LOOKUP in the column labeled "Grade." This function will look up a number in the first column of a table and return whatever the value is in the corresponding last column of the table. The look up always returns the value in the table that is closest without exceeding the value being looked up. In this case, the table is at the bottom right of the sheet. Consider the student named Albrecht. Her average of 73.6 is looked up in the table. "Seventy" is the number that is closest to 73.6 without exceeding it; so the grade "C" is returned.

With Multiplan you can sort data in ascending or descending order, as has been done on the grade sheet. As the students' names are sorted, the grades and averages remain associated with the correct names. Sorting on Multiplan must be done judiciously, however. If sorting occurs on rows where formulas refer to different rows within the sort, unwanted values result. After the sort, the formula will refer to a cell that may no longer contain the same information as it did before the sort. In this sheet, the formula for the averages is identical for each student and always refers to cells on the same row, so the sort can be performed.

[1] This Multiplan application was developed by Lucy Wozny, Information Services Coordinator, Computer Center, Drexel University.

	1	2	3	4	5	6	7	8
1	Grade Sheet for Music 122							
2	==========							
3	STUDENT NAME	TEST1	TEST2	TEST3	TEST4	FINAL	AVER.	GRADE
4	Albrecht, J	75	72	77	70	74	73.6	C
5	Boardway, J	96	98	90	89	92	93	A
6	Dahm, N	65	50	53	45	0	42.6	F
7	Hartman, L	85	72	84	87	80	81.6	B
8	Schuch, L	95	92	85	87	93	90.4	A
9								
10					GRADE TABLE			
11					0	F		
12					60	D		
13					70	C		
14					80	B		
15					90	A		

Figure 3. Grade Tally

Production Decisions.[2] Figure 4 presents a decision analysis tool in which the costs of four different methods of making the same quantity of product are compared to determine which method will cost the least. All four methods require tools, men, material, and machines, but they require different amounts of each. The PRODUCTION METHODS section of the sheet lays out the four methods (I, II, III, and IV) and the component requirements of each. The data presented here indicate that some processes are more labor intensive (e.g., Method III), while others are more capital intensive (e.g., Methods I).

The cost of one unit of each component (tools, men, material, and machines) is presented in the COST OF section. The COST OF METHODS , then, contains the sum of the total cost for each component (amount of items required times cost per item). The per component cost and the sum of component costs for each method is calculated in one formula and produced in the third section of the sheet.

The final section of the sheet gives the total cost of the low cost method ($285,000), the name of that method (III), and states that that method has been chosen. To test for the least expensive method of production, this sheet uses the IF statement coupled with the MIN function. The MIN function returns the minimum value in a series of values. Here the MIN function acts on the "Cost of Methods" section of the sheet and returns the minimum cost method. Thus, IF the method is the least expensive (if its cost is the minimum value), then return it as the low cost method.

This sheet is mathematically simple. The major calculations are multiplication and addition. Yet it provides a powerful analytic tool because as the cost per unit or the number of components needed for any method is changed, the decision on which production method to use is also changed.

---

[2] This Multiplan application was developed by Edward Koziara, Professor of Economics, Drexel University.

	2	3	4	5	6	7
1	PRODUCTION METHODS		I	II	III	IV
2		Tools	135	100	300	400
3		Men	345	178	500	100
4		Material	90	100	30	600
5		Machines	2,000	456	20	100
6						
7	COST OF:		Tools	Men	Material	Machines
8	(in dollars)		700	100	500	500
9						
10	COST OF METHODS		I	II	III	IV
11	(in dollars)		1,174,000	365,800	285,000	640,000
12						
13						
14	LOW COST METHOD:		285,000	III	Method III chosen.	

Figure 4. Production Decisions

Nutritional Analysis.[3] A database of foods and their nutritional values is represented in Figure 5. In Figure 6. the nutritional value of a specific menu item (fruit salad) is calculated by combining the information from the nutritional analysis of foods listed in Figure 5. with the amount of each food used in a recipe for that item.

A portion of the foods database beginning with "grapes" and ending with "pineapple" is presented in Figure 5. For each food, a measurement unit is given, followed by the calorie count, and grams of protein, fat, and carbohydrate per unit. The column labels, (FOOD, UNIT, CAL, etc.) correspond with the column labels in Figure 6. In addition to the nutritional information presented here, there are other columns for each food's content of 10 other vitamins and minerals. Data are from the USDA Handbook No. 456, "Nutritive Values of American Foods."

The foods database in Figure 5. makes extensive use of Multiplan's ability to name a given part of a spreadsheet. The first cell of each row of information (food units and nutritients) in the database contains an index number, and is given a Multiplan name which is the same as the food item's name. Thus, the row that has the information on mushrooms begins with an index number () in the first cell, named "mushroom."

Figure 6. is a nutritional breakdown of a fruit salad. Each ingredient in the salad is input by an ingenious means. The user inputs the name of the food he wants into the first cell of a row. Multiplan displays the corresponding the index number for the name of the food. The rest of the nutritional information for the food is input using the INDEX function in Multiplan. The INDEX function finds the row in the database that begins with the index number, and copies the ingredient information into the menu item. The user next inputs how much of the food he wants, based upon the unit given. Nutrient content per unit from the database is multiplied by the number of units. In the fruit salad example, there is about 1/4 cup of coconut and two whole grapefruits (four 1/2 fruits). Finally, the user inputs the number of servings for the dish. In this case, the fruit salad should serve eight people. Multiplan calculates the total calories, protein, fat, and other nutritional values for each serving.

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[3] This Multiplan application was developed by Thomsen Hansen, Assistant Professor of Nutritional and Food Sciences, Drexel University.

	1	2	3	4	5	6	7	8
33	19	FOOD	#	UNIT	CAL	PRO	FAT	CHO
34	20	grapefruit		1/2 fruit	39	0.81	0.12	9.92
35	21	grapes		1 cup	58	0.58	0.32	15.78
36	22	ham, boiled sliced		1 slice, 2	52	4.98	3	0.88
37	23	honeydew		1 cup, cubi	60	0.77	0.17	15.61
38	24	ice cream, vanilla		133 gram	269	4.8	14.32	31.72
39	25	leeks		100 g.	52	2.2	0.3	11.2
40	26	lettuce romaine cali		1 lb.	52	3.8	0.9	10.2
41	27	mushrooms, raw		1 lb.	123	11.9	1.3	19.4
42	28	olives ripe jumbo		1 lb.	263	2.2	28.2	5.3
43	29	peaches		1 piece	37	0.61	0.08	9.65
44	30	pears		1 piece	98	0.65	0.66	25.09
45	31	peppers, hot cherry		1 lb.	113	4.1	0.5	27.7
46	32	pickles, kosher chips		1 lb.	50	3.2	0.9	10
47	33	pineapple, diced		1 c.	77	0.6	0.66	19.21

Figure 5. Foods Database

	1	2	3	4	5	6	7	8
1		FOOD	#	UNIT	CAL	PRO	FAT	CHO
2	7	cantaloupe	3	1 cup, cu	171	4.2	1.32	40.14
3	13	coconut, grated,	0.2	1 lb.	497.2	3.26	35.48	48.26
4	20	grapefruit	4	1/2 fruit	156	3.24	0.48	39.68
5	21	grapes	2	1 cup	116	1.16	0.64	31.56
6	29	peaches	4	1 piece	148	2.44	0.32	38.6
7	30	pears	3	1 piece	294	1.95	1.98	75.27
8	33	pineapple, diced	3	1 c.	231	1.8	1.98	57.63
9	43	watermelon	3	1 cup, dic	150	2.97	2.04	34.47
10	1				0	0	0	0
11	1				0	0	0	0
12	1				0	0	0	0
13	1				0	0	0	0
14		# of servings:	8	tot/serv	220	3	6	46

Figure 6. Nutritional Analysis

Chemical Equilibrium Calculations.[4] A series of three spreadsheets has been developed at Drexel University which use Multiplan to perform calculations on the "properties of solutions of weak acids and bases including buffer solutions." Figure 7. displays the weak acids spreadsheet.

The sheet is based on the chemical reaction of the ionization of a weak acid. The calculation is valid when certain criteria concerning the actual concentration of an acid are met. The criteria pertaining to a weak acid are written at the bottom of the sheet: "(H+)<3E-7M or c(total)". Properties of an acid are input and manipulated. If these criteria are not met based upon the input and manipulation, an error message is generated.

The input consists of two of the three properties of an acid: the concentration, the pH factor and/or the pK_a factor. The input lines are desiginated "input" and are distinguishable by the dotted lines that mark them. The mathematical calculations describing the properties of a weak acid are performed in cells not visible on the screen. The sheet returns the remaining factor based on the relationships between the three factors. These are the fields that are labeled "output". If the resulting factor does not satisfy the validity criteria, an error message is generated next to the output value.

The Multiplan functions that are used in this sheet are both computational and logical. The computational functions derive from the equilibrium, mass and charge balance equations for the weak acid and the definitions of pH and pK_a. The functions used are exponentiation, logarithms, square roots, multiplication, addition, and subtraction. The logical functions of IF and AND are used to create the conditions of the output and the form of the output (i.e., IF the pH and concentration are input, generate the pK_a factor; IF the criteria are not met, generate an error message.)

This sheet also features protection against changes in the formulas. Students may enter data only on the three visible dotted lines. The remainder of the sheet is protected.

[4] This Multiplan application was developed by James P. Friend, Hanson Professor of Atmospheric Chemistry, Drexel University.

	1	2	3	4
1	CALCULATIONS FOR A WEAK ACID			
2	Computations valid for dilute solutions: concentrations ≤ 1M			
3	VARIABLE	VALUE		
4	pK(input)	9.32	INPUTS GO INTO TWO	
5	pH(input)		OF THESE THREE	
6	total conc.(M) (input)	0.1	ROWS	
7	pK(output)			
8	pH(output)	5.160		
9	total conc.(M) (output)			
10				
11				
12	frac. dissoc. (output)	0.000		
13			Check above for ERROR	
14	ERROR appears next to output value when (H+)<3E-7M or > c(total).			

Figure 7. Weak Acid Equilibrium

Least Squares Analysis.[3] Least squares analysis (or linear regression) is a statistical tool used to judge how observed pairs of data best fit a straight line. In Figure 8., it can be seen that the observed data are scattered about the line that describes the data. Least squares analysis calculates a line that minimizes the differences between the observed values and the line that best describes them. Figure 9. presents a least squares analysis using Multiplan.

The student or researcher inputs the paired data of x and y in columns 1 and 2 of the sheet. Although only 11 pairs are visible on the sheet, the number of data pairs can be increased as needed. The rest of the spreadsheet is based upon formulas and the results of the formulas are returned.

The heart of the least squares calculations is located in another portion of the sheet and is represented by Figure 10. The number of data pairs is determined by using the COUNT function. The SUM function returns the figures labeled "sum". Some of the sums are based upon intermediate calculations contained in a table on a portion of the spreadsheet not displayed here. The values at the bottom of Figure 10. are carried over as the computed slope, intercept, and correlation coefficient on the right of Figure 8.

On the main sheet, the "Computed Y-values" use the slope and intercept to return the Y values of the straight line. The bar graph depicts the distance between the observed Y value and the calculated Y value. That is to say, the closer the observed Y and the calculated Y, the better the fit of the line to the observed data. If the observed data are represented exactly, then the graph would show only zero (Calculated Y-observed Y=0).

The graph is produced by a Multiplan format that transforms any number into a bar graph. The double-sided graph on this sheet is accomplished by use of an IF statement. If (Calculated Y-Observed Y)<0, the cell to the left of the zero mark is filled; if (Calculated Y-Observed Y)>0, the cell to the right of the zero mark is filled.

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[5] This Multiplan application was developed by Allan L. Smith, Professor of Chemistry, Drexel University.

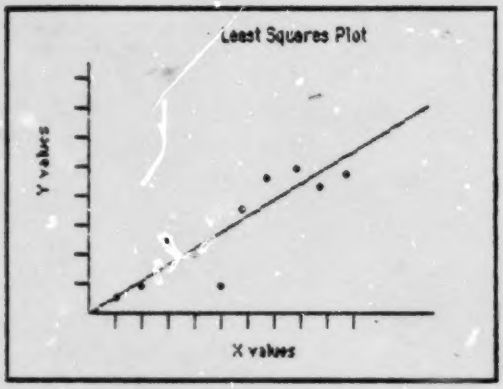

Figure 8. Least Squares Plot

	13	14	15
1	Number of X,Y data pairs =		11
2	The sum of all X(i) =		67.87
3	The sum of all Y(i) =		111
4	The sum of all X(i)^2 =		490.9891
5	The sum of all Y(i)^2 =		1331
6	The sum of all X(i)*Y(i) =		808.21
7			
8	The slope of the line =		1.7075724
9	The intercept =		-0.444812
10	The correlation coefficient =		0.9985913

Figure 10. Least Squares Calculations

	1	2	3	4	5	6	7
1	LINEAR LEAST SQUARES ANALYSIS						THE COMPUTED
2							SLOPE IS
3	Enter X-	Enter Y-	Computed	Y(enter)-	Percent Residuals		1.7076
4	here	here	Y-values	Y(comp)	-5 0 +5		
5	**********						
6	1.5	2	2.12	-0.117			THE COMPUTED
7	2.5	4	3.82	0.176			INTERCEPT
8	3.84	6	6.11	-0.112			IS
9	4.84	8	7.82	0.180			-0.4448
10	6.17	10	10.09	-0.091			
11	7.17	12	11.80	0.202			THE COMPUTED
12	8.5	14	14.07	-0.070			CORRELATION
13	9.5	16	15.78	0.223			COEFFICIENT IS
14	9.17	15	15.21	-0.214			0.9986
15	7.84	13	12.94	0.057			
16	6.84	11	11.23	-0.235			

Figure 9. Least Squares Analysis

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Production Possibility Curve[6]

Figure 11. is different from the rest of the spreadsheets presented in this paper in that it is a spreadsheet that students create as a homework assignment. The format for the table is specified. Students are expected to use MacPaint to create the plot of Q(x) given Q(y) based on the table that they have developed. The actual student assignment is presented in Figure 12.

This is the first assignment in a 10 week "Economics I" course. Students receive a total of 10 Multiplan assignments in this course. Each one focuses on an economic principle. Two skills that a student must exhibit are an understanding of the assignment's economic principle and the transfer of the principle into a spreadsheet form. Before doing the assignment, they are exposed to both the principle and the spreadsheet in the classroom situation. Using a Macintosh projection system, the teacher is able to present realistic examples to the class.

As the weeks progress, the principles become more complicated while the information about spreadsheet set-up in the assignment becomes less evident. By the second economics course, the format specifications are no longer included in the assignments. As students work through the problems each week, Multiplan becomes a tool used to solve a problem, rather than the focus of the assignment.

The "Economics I" course has even included some questions on spreadsheet techniques on the course exams. For example, a student may be asked, "Which IF statement is correct for the maximization of profit for two different methods?" Questions such as these are testing the student's ability to recognize the economics equation, not the IF statement syntax.

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[6] This Multiplan application was developed by Chiou-Shuang J. Yan, Professor of Economics, Drexel University.

	1	2	3	4
1				
2				
3	MEN	Q(X)	Q(Y)	Q(X) GIVEN Q(Y)
4				
5	0			
6	10			
7	20			
8	30			
9	40			
10	50			
11	60			
12	70			
13	80			
14	90			
15	100			

Figure 11. Production Possibility Curve

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Economics I: Problem Set 1
Production Possibility Curve: The Case of Drexelia

A tiny Asian country named Drexelia has a labor force of 100 men and produces two goods, X and Y. X is a necessity and Y is a luxury item. The output levels of X and Y depend solely upon the input of labor as follows:

$$Q(X) = 200\,M(X) + 2M(X)^2 - .02M(X)^3 \qquad (1)$$
$$Q(Y) = 200\,M(Y) + 2M(Y)^2 - .02M(Y)^3 \qquad (2)$$

where Q(X)= quantity of X produced
Q(Y)= quantity of Y produced
M(X)= number of men assigned to the production of X
M(Y)= number of men assigned to the production of Y

Find the production possibility curve of Drexelia both in tabular and graph form using Multiplan and MacPaint.

Hint: One way of obtaining the numbers in column (4) is to replace M(X) in equation (1) by (100-M(Y)).

Figure 12. Production Possibility Assignment